Chapter 8

The Effect of Renewable Energy Sources on Animal Production

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Abstract

The growing world population and the associated demand for energy are increasing the importance of renewable energy sources. Due to the limited nature of fossil fuels, their environmental damage, and energy security risks, there has been a shift towards renewable energy sources such as solar, wind, geothermal, hydraulic, and biomass. However, the negative effects of these sources, particularly on crop production and livestock farming, are being debated. Solar and wind power plants, which are built on large areas, lead to the reduction of agricultural land and pastures, as well as the decrease and loss of grazing areas. This situation particularly affects nomadic livestock farming and small producers. Furthermore, the noise, vibration, and electromagnetic fields generated by turbines can cause stress in animals, reduced productivity in some cases, and orientation problems. While solar panels create shaded areas that may benefit animals in some situations, they can negatively affect plant growth and forage quality. Infrastructure development for renewable energy makes it difficult for animals to access water and pastures. Wind turbines also have a negative impact on bees and other pollinating insects. Turbulence, pressure differences, and electromagnetic fields cause bee deaths. This indirectly threatens agricultural production, even if not directly. In conclusion, although renewable energy production is necessary from an environmental perspective, it must be planned in a way that does not disrupt agricultural activities.

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1. INTRODUCTION

The world's population continues to grow as the years progress. Naturally, humanity's needs also increase in line with this population growth. The most important of these needs is energy. There is a direct relationship between energy consumption, which is a fundamental element of economic development, and living standards (Karaca, 2017). In response to the increasing demand for energy, the limited nature of fossil fuel resources, as well as their impact on the environment and climate change, has brought the use of different energy sources to the forefront (Gürbüz et al., 2021). This situation has shown a high rate of increase in recent years, and almost every country has turned to renewable energy sources (Kaya et al., 2019; Khanlari et al., 2020a; 2020b).

Countries around the world meet a large part of their energy needs from fossil fuels. However, energy sources such as natural gas, coal, and oil have limited reserves. These resources are at risk of depletion. Furthermore, the use of limited resources threatens energy security and causes environmental problems (Yaşar et al., 2025).

It is very important to produce energy using renewable, clean, and sustainable sources. However, production must be carried out taking into account both positive and negative environmental factors (Gürbüz et al., 2021). Energy obtained from renewable sources is also important in terms of increasing national energy security, reducing imports, and lowering greenhouse gas emissions (Lopez et al., 2024).

The renewable energy sources we will examine for their impact on livestock are solar and wind energy. In addition to these, geothermal, hydraulic, and biomass energy should also be noted (Gürbüz et al., 2021).

2. THE NEGATIVE EFFECTS OF RENEWABLE ENERGY SOURCES ON LIVESTOCK FARMING

Most of the land used in many regions of our country is for agricultural purposes. From this perspective, the agricultural sector has significant potential for renewable energy. The vast expanses of land are well-suited for wind and solar energy. In addition, residues from both plant and animal production provide raw materials for biofuel or biomaterial. (Gürbüz and Kadağan, 2019; 2022).

Due to the continuous growth of the world population, the demand for food is increasing day by day. To meet this growing demand for food, new agricultural lands and high-yield soils are needed. Unfortunately, however,

the world's agricultural lands are on a downward trend (Karakuş et al., 2019).

Given current economic developments and population growth rates, it is reported that by 2030, global food demand will increase by 50%, energy demand by 40%, and water demand by 30%. According to these reports, the world will face difficult times in terms of basic needs such as food and energy. Along with the growing population, many needs are also emerging. While these needs are important, they also lead to the use of agricultural land for purposes other than its intended use (Aksoy, 1997; Bıçakçı et al., 2023). Examples of these include:

- Regulation and growth of urbanization,
- Industrialization and the increasing development of industry,
- The need for and development of the mining sector,
- Construction of highways,
- Continued construction of airports,
- Construction of railways such as high-speed trains,
- Expansion of recreational areas,
- Need for tourist areas and continuous expansion of these areas,
- Creation of protected areas,
- Creation of infrastructure related to urbanization and industrialization,
- Construction of dams for energy needs and irrigation,
- Construction of canals,
- Creation of pipelines for natural gas, fuel, etc.,
- Construction of power plants for energy needs.

Türkiye is home to some of the world's most important bird migration routes. Therefore, to minimize risks related to GES projects and birds, monitoring studies should be conducted at least twice a year (spring and fall) during the periods when bird migration occurs. This is particularly important after solar panels have been installed. This is because, after the panels are installed, a still water surface appears on the panels when viewed from above. In this case, there is a possibility that birds may mistake the panels for a still water surface while flying (Turan et al., 2023).

Naturally, measures can be taken to prevent this situation by using audible, visual, and moving deterrents, thereby mitigating the risks. There

are a limited number of scientific studies conducted and published on these topics. It is crucial to be sensitive to this issue in solar power plant projects in our country and to implement the necessary measures (Turan et al., 2023).

Figure 1. A vulture killed by the impact of wind turbine blades (Photo: Atabey, 2022)

The presence of wind turbines in bird migration areas poses significant problems. Birds living in forests and wetlands (including bats) are negatively affected by wind turbines, leading to an increase in harmful insects not only within the forest but also in surrounding agricultural areas, olive groves, and orchards (Kantarcı, 2015).

Research conducted to determine why birds, especially bats, are drawn to wind turbines has identified some possible reasons, although these are not definitive (Atabey, 2022). These include:

- Sound-directed movement,
- Loss of sense of direction due to electromagnetic fields,
- Approach due to heat effect,
- For roosting and night-time activity,
- Linear corridor (farms built on ridges may be a good option for covering distance),
- Orientation may occur due to the presence of a high area on the migration route for mating behavior. Wind turbine-related deaths may occur for these reasons.

Figure 2. Blade hub on a wind turbine (Photo: https://khosann.com)

The health issue known as "wind turbine syndrome" caused by the low-frequency sound and shadow flicker effects emitted by wind turbines, is one of the most significant and rare effects observed in humans (Pierpont,

2009). To overcome this problem, buffer zones between wind turbines and residential areas have been established in many countries in recent years through the enactment of laws and regulations. Nevertheless, wind energy remains the renewable energy source that causes the least environmental problems (Kadıoğlu and Tellioğlu, 1996).

Solar power plants built on large areas can negatively affect the ecosystem and biodiversity of their surroundings. They can restrict the vital movements of living creatures in these areas. The ecosystem and biodiversity are negatively affected by factors such as light reflections, high temperatures on the surface of the panels, the magnetic field created, changes in the microclimate, and the reduction of vegetation and water resources (Tsoutsos et al., 2005; Sarsıcı, 2020).

Although renewable energy projects generally prioritize environmental benefits, some negative effects on livestock activities are anticipated. These effects may vary depending on the type, size, and location of the energy facility, the type of animal raised, the current land use, and the management practices applied.

2. 1. Land use and loss of grazing areas

Large-scale solar farms and wind turbine infrastructure cause land loss in pasture and grazing areas. This situation poses a significant problem, particularly for small-scale producers and farmers engaged in nomadic livestock farming (Karadeli, 2001).

Renewable energy projects can reduce the boundaries of areas such as pastures or grazing lands where animals need to graze. Land reduction is likely to occur, especially in systems where animals are fed seasonally in a nomadic manner (Karadeli, 2001).

Facility construction on pasture areas can restrict grazing activities in those areas. Clearing operations in forested areas or areas that are not actually forested cause significant damage to these areas. Ground clearing operations in areas such as scrubland, heathland, marshes, and reed beds can cause permanent damage to the flora, fauna, and land. Any intervention in such areas may also result in the loss of these areas (Bıçakcı et al., 2023).

Despite this, a counterargument is also defended. According to this view, wind power plants occupy more space than other power plants. This is because these turbines are spaced far apart so that they do not block each other's wind. Consequently, for example, 20 turbines, which is a large number, cover an area of approximately 1 km2. However, only 1-1.5%

of this area is actually occupied by the turbines. The vast area outside the turbine installation zone can be easily used as agricultural land or for various livestock activities (pasture-meadow), provided that no structures are built that would block the wind (Hayli, 2001).

Following the enactment of Law No. 4342 on Pastures in 1998, various beneficial applications required by law began to be implemented on pastures. The practices outlined in the law are essentially grouped under four main headings: the identification, delimitation, and allocation of pastures, as well as pasture improvement projects planned and implemented to restore pastures that have become worn out and unproductive for various reasons to their former productive state. Law No. 4342 also includes regulations and instructions for the allocation of certain pasture areas to the public and private sectors for the purpose of providing public services that meet the basic needs of society, primarily our national security, natural disasters, and our country's energy needs. According to these regulations, if it is considered that establishing a solar power plant (GES) or wind power plant (RES) on a pasture area is the best solution under current conditions, low-yield pasture areas should be preferred (Bıçakcı et al., 2023).

Figure 3. Goat herds in the field of solar energy (Photo: https://www.piagrid.com/rehber/hayvancilik-icin-gunes-enerjisi)

2. 2. Noise, vibration, and visual - public interaction stress

Wind turbines can generate noise and low-frequency sounds from sources such as rotational movements, tower foundations, and generator noise. Such sounds are predicted to cause effects on animal behavior, including stress, loss of appetite, and decreased milk production. However, studies in this area have often failed to produce clear results. There are also findings suggesting that the effects are low or limited in the context of animal husbandry (Anses, 2021; Energy Savings Lab, 2025; ELC, 2025).

In particular, vibrations from wind turbines or construction work during infrastructure development can be a source of disturbance for animals. For example, activities such as road construction and foundation excavation for large wind farms, although temporary, can cause some negative effects (Chiu et al., 2020).

To prevent this and take precautions in advance, the necessary measures should be presented in the EIA reports prepared.

2. 3. Shading, microclimate changes, and heat stress

Solar panels can potentially have positive effects on animals by creating shade. They can also play an important role in protecting animals from heat stress during hot weather. However, plant growth rate and quality may change in shaded areas. Solar energy facilities can disrupt the homogeneity of plant cover. In this case, negative effects may arise in terms of quality and price in animal nutrition (Andrew et al., 2021; Faria et al., 2023).

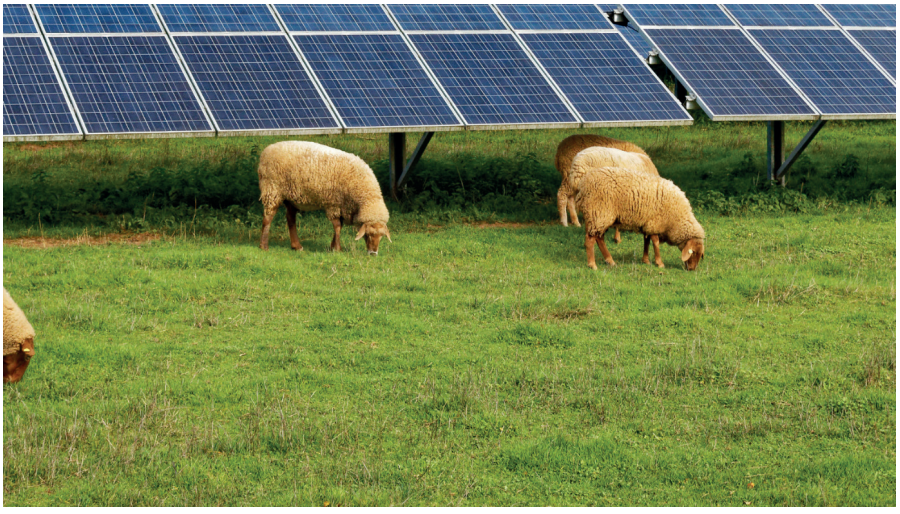

Figure 4. A flock of sheep in a solar panel field (Photo: https://temizenerji.org)

Depending on shading and panel configuration, the photosynthetic capacity of plants benefiting from sunlight may decrease. This situation may be felt more particularly in regions with sunny climates where plant growth is closely related to light (Velilla et al., 2021).

2. 4. Transportation, access issues, and infrastructure barriers

The foundations of turbines, the installation areas for solar panels, maintenance and service roads, and roads constructed for grid connections can divide pasture or grazing areas, potentially restricting the free movement of animals (Marsh, 2023).

When areas are separated, animals' access to water sources or shaded areas may be reduced. In this case, risks to individual animal health may arise, especially in hot weather (Chiu et al., 2021).

2. 5. Social and cultural dimensions

Nomadic pastoralism is a production system carried out on pastures and summer pastures. Renewable energy projects can sometimes affect local communities' pasture traditions or reduce common use areas (Chiu et al., 2021).

Failure to involve local people in project planning and site selection, as well as practices such as fencing and infrastructure development, can limit animals' access to grazing and water.

3. THE NEGATIVE EFFECTS OF RENEWABLE ENERGY SOURCES ON BEEKEEPING

Bees play a crucial role in agricultural sustainability. Since bees help ensure pollination, a large bee population is essential for the continuity of agriculture (Corten et al., 2001; Pustkowiak et al., 2017). Approximately 90% of plants require the assistance of pollinators. Bees are also the most effective pollinators.

More than half of the wind hitting the blades of wind turbines is converted into kinetic energy. The remaining wind can be scattered at high speeds. This can cause moist air on the ground to rise, causing significant damage to the surrounding bee population. Furthermore, the turbulence and pressure differences created around the turbine cause permanent physical damage to bees (Kantarcı, 2015).

Rotating wind turbine blades can be a deadly mechanism for insects and bees. In addition to this lethal effect, the turbulence and pressure differences

around the turbine can also cause permanent physical damage to bees. Insect and bee deaths caused by turbine blades result in the scattering of fragmented insects and the formation of odors. This odor formation will also attract other winged animals. Thus, this situation continues to escalate (Gürbüz et al., 2021). Due to the noise generated by wind turbine blades and the stray voltage caused by leakage currents, bees become disoriented and lost. The electromagnetic field effect of wind turbines can prevent honeybees from finding their direction, food source, or hive (Atabey, 2022).

The presence of insects and bees can also affect wind turbine performance. The incompatibility of flying insects with wind turbines is a significant problem. Insect remains on wind turbine blades can cause reductions in wind turbine performance. Additionally, insect and other animal deaths cause cleaning problems on the blades.

4. CONCLUSION AND RECOMMENDATIONS

The allocation of first and second class agricultural land for the purpose of developing public services or meeting public needs leads to the use of these areas for non-agricultural purposes. Although the regulations and instructions of Law No. 4342 on Pastures, Law No. 2872 on the Environment, and Law No. 5403 on Soil Protection and Land Use apply to these allocated lands, the demand for energy and food is increasing along with the growing population. Unfortunately, this situation is an inevitable reality. At this point, it is necessary to ensure that agricultural production is sufficient for the growing population and that the energy needs of the growing population are met. It is essential to act in a planned manner in the use of land resources and to carefully select areas for energy production, especially those to be used for purposes other than food. If land is used for purposes other than its intended use and this situation is not controlled, countries may be driven into disaster in the near future.

While using our country's renewable energy potential in the most efficient way, it is of great importance not to disrupt agricultural activities, to ensure the production of feed necessary for animal production, and to protect our pasture and grazing areas, which are the cheapest source for meeting the high-quality roughage needs of farm animals.

In today's world, where agricultural land, one of the limited and almost fully utilized resources, is becoming increasingly important, the misuse of these areas must be prevented. This is because our animal protein needs will become a significant problem as the years progress. The decline in agricultural areas such as pastures will lead to a decline in animal husbandry.

Significant effort must be made to ensure that the ecological benefits of renewable energy production translate into benefits for rural areas as well. Technological developments at the global and national levels will have both positive and negative effects on plant and animal production when implemented in rural areas. Therefore, we can make renewable energy production sustainable not through a centralized approach, but as a process that also includes rural areas. It is believed that progressing in this manner will lead to more applications for renewable energy production and raise awareness among people living in rural areas.

Pasture grazing areas, transportation corridors, and shaded areas must be taken into consideration when selecting project locations. Noise, vibration, and shading effects should be assessed according to animal species, and adjustments should be made to panel/turbine placement, distance, and protective fencing. Shaded areas, access to water sources, observation paths, etc. should be planned with the needs of animals in mind. The opinions of local communities engaged in animal husbandry should be sought, and local cultural practices should be taken into account.

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